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USING MOBILE TECHNOLOGY TO FACILITATE THE HEALTH AGENDA IN NIGERIA: ISSUES AND OPPORTUNITIES

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Abstract

In today's information and technology era, new opportunities abound for the use of information and communication technologies (ICT), particularly in less developed regions, for the purpose of addressing healthcare challenges in the provision of quality care to citizens. A key element is poor dissemination of timely knowledge and information to improve public health and support decision making in order to bring about improvements in all areas of healthcare delivery. This paper describes a study into efforts made in Nigeria to introduce and use mobile phone technology to improve routine maternal health operations and monitor key maternal and child health indicators throughout the country. Actor network theory (ANT) is employed as a rich theoretical lens to aid the analysis of the field data that was collected. The ANT analysis offers in-depth insights into underlying opportunities and issues of the use of this ICT solution. Particularly, it finds that it is important for initiative sponsor(s) to thoughtfully problematise this kind of initiative in order to better align the interests of key actors to the overall goal of the network so that human actors will come to realise their own role within the network by themselves and will not require other actors (such as the project initiator) to compel them to perform certain roles. The paper concludes with implications for future actions towards ensuring that networks such as this achieve stability which will in turn enable it to become durable and established over time.

Keywords: Actor-Network Theory, Mobile Phones, Maternal and Child Health, Nigeria

1 Introduction

Harnessing digital information and communication technologies has become a key feature of the attempt by least developed countries (LDC) to make progress towards reducing poverty, improving the health and living conditions for its citizens and ultimately achieving socio-economic development.

Nigeria is an interesting case that has taken to digitization rather later than some of its counterparts like Ghana within Sub-Saharan Africa or even countries in Asia such as India. Nevertheless it has achieved some success, such as in the banking sector. This sector is an interesting example of the successful use of ICTs particularly mobile phones to bring about reform in business process while at the same time improving banking services and extending it to the reach of citizens particularly those of very low-income. Currently, mobile phones provide a new channel of delivering financial and banking services to the entire population in a convenient and cost effective manner. For instance, by exploiting one of its basic functionality i.e. the use of SMS for task ranging from local and international money transfer, bill payments; mobile solutions brings clear benefits to citizens by removing the need for journeys thereby saving money and time. While this is a prime example of successfully using ICT in Nigeria's for-profit sector, there still remains a large part of its economy where the degree of penetration of ICTs to improve business processes and services to citizens in its public or not for-profit sector is still relatively slow.

This paper therefore examines the application of ICT particularly mobile technology in one such area of public sector activity in Nigeria, namely that of primary healthcare. The intent here is to utilise ICTs to support the provision of quality maternal and child healthcare in an affordable and sustainable manner that will meet changing health care needs of its citizens. Nigeria is divided into 36 states and the federal capital territory (FCT), these are further subdivided into approximately 774 local government areas (LGA). Within each of these local governments, are primary health facilities aimed at bringing health services nearer to where people live and work.

A major initiative for the introduction and use of mobile phones within primary healthcare in Nigeria started in 2009 under a nationwide initiative called the midwives service scheme (MSS). This public sector initiative by the Nigerian government is in response to the United Nations (UN) Millennium Development Goals (MDGs) 4 and 5 that require member states to reduce child and maternal mortality by 75% by the year 2015. The MDGs (eight in number) emerged from a three day summit by international development organisations and about 189 world leaders of member states in September 2000 at the UN headquarters. These goals are regarded as a critical agenda for the UN as it aims to alleviate poverty globally while improving health and education as well as fostering gender equality.

With time scales short and slow progress detected so far towards Nigeria's attainment of these goals, the government of Nigeria did what every other government does in such circumstance: roll out projects targeted at accelerating the pace of achieving its target.

The MSS as mentioned earlier, is one of such projects with a central objective of improving skilled attendance at birth so as to help reduce maternal, newborn and child morbidity and mortality by up to 60% in line with the MDG 4 and 5. To achieve this goal, eight (8) strategic components have been designed as part of this scheme among which include, capacity building and training of midwives, management and coordination, monitoring, evaluation and the ICT support component, deployment of midwives to health facilities to improve the coverage of skilled attendance at birth etc. However the particular focus of this paper concerns an aspect of the ICT component that supports this initiative and which has not been reported on previously. This aspect is known as the Mobile-Application Data Exchange System (MADEX): a system that makes use of mobile phone technology to strengthen the health information system.

The relevance of this research and the reason it has been chosen as a topic for study is because research that examines the harnessing of digital technologies (e.g. mobile phones) and its use in addressing challenges in health systems of LDC with the objective of bringing about improvement is still in its infancy. This is not to say research in this field is new, rather it means that the field is still under researched as a large proportion of studies till date still report mainly on single pilot projects and not

wide-scale applications. Therefore understanding the changes accompanying the introduction of technologies such as mobile phones in health systems of LDC as well as the challenges presented by this new way of working is important to successfully exploit the capabilities of these technologies.

In the general context of developing countries, it has been noted by international development agencies as well as the research community that mobile phones have immense potentials as a tool for delivering information and services (Heeks, 2010). This is not just in view of the fact that they can deliver sufficient functionality but because they are a simple and cheap form of technology suitable for use in rural areas owing to their low dependency on regular power supply and complex infrastructure. Therefore with very little research being achieved in terms of using mobile phones for large scale applications, this study complements existing work in this field by empirically examining the issues and opportunities of introducing a mobile phone based reporting system in Nigeria. This system is designed to aid the capturing of health data on key maternal and child health indicators from primary health facilities across the country and reporting it to the national level for the purpose of assessment of progress towards the MDGs 4 and 5, for planning purposes and for the mobilisation of resources.

This research therefore reflects upon the events taking place at the micro-level of the primary health facilities and also at the “macro-level” of the national level. It seeks to address a number of questions and they are as follows: has mobile phone technology been used in a sustainable way in this national maternal and child health system (as regards the longevity of this new way of working and its existence over time), and if not, why is this so and what needs to be done in the future? Second, has the introduction and use of mobile phones in this system created awareness as well as fuelled acceptance of the benefits of mobile phone in enhancing health care delivery?

To fully understand the introduction and use of mobile phones in the given context, it is useful to employ actor-network theory (ANT) as a rich theoretical lens. The key reason being that efforts to introduce and use technology involve many actors, which can make the resulting process quite complex in nature.

Therefore the successful use of the technology and its application will require a blend of both technical excellence and social acceptance.

Consequently, ANT which is viewed as a systematic approach to structuring and explaining the complex phenomenon of convergence between society and technology may offer insights into what factors might influence the introduction of this technology and its application by groups of people in this social setting. Indeed, these insights may prove invaluable in the integration and sustainable use of mobile technology, as it may raise valuable question around social, cultural or political issues in the minds of the project initiators and managers.

The remainder of this paper is organised as follows. In the next and second section, a brief overview of actor-network theory and its suitability as a rich theoretical lens for this study will be provided. This section will also include a discussion on some of the key concepts of ANT used in this study. In section three, the research approach and methodology adopted for this study will be discussed briefly. The subsequent section will focus on providing a brief background to the healthcare context as well as the case study description. Following that, section five focuses on presenting the result which is closely followed by the discussion. Finally, some concluding remarks are provided in the sixth section of this paper.

2 Actor-Network Theory (ANT)

Actor network theory (ANT) also known as the “sociology of translation” (Callon 1986b; Law, 1992) has its origins in the field of science and technology studies (STS). It is basically concerned with the study of the association between humans and non-humans (Latour, 1986). Essentially, it places emphasis on examining and explaining the motivations and actions of actors, linked by associations of heterogeneous networks of aligned interests (Walsham and Sahay, 1999). It also places emphasis on demonstrating how associations emerge, come into being, and how they are maintained and transformed to become more durable and stable over time (Latour, 2005). A key feature of the theory is that it is based on the principle of general symmetry and free association (Callon 1986b). It argues against the dualist paradigm within sociology (Dolwick, 2009) which gives due recognition to both the human and non-human elements of a system but tends to consider the effect of both the human

and non-humans in different ways hence privileging one over the other. Hence a major focus of the theory when applied in specific contexts is to attempt impartiality when giving consideration to actors whether they are human or non-human. As Callon puts it:

The rule which we must respect is not to change registers when we move from the technical to the social aspect of the problem being investigated (Callon 1986b:200)

ANT evolved from the work of two French STS scholars in the 1980s namely: Bruno Latour and Michel Callon and a British sociologist John Law (Callon and Latour, 1981; Callon, 1986a; Law 1986). Although commonly referred to as a “theory” ANT is not necessarily a theory as theories not only describe a set of phenomena, they also possess the ability to predict behaviour or tend to offer explanation about why certain things happen. Consequently ANT is best understood as a framework of analysis for describing socio-technical scenarios. It has proven useful in informing information systems research both in developed and less developed countries. For instance, ANT has informed the analysis of information technology for development (ICT4D) projects in LDC (Diaz Andrade and Urquhart, 2010; Walsham and Sahay, 1999). Similarly, it has also informed the analysis of many health information systems research (Cho *et al.*, 2007; Braa *et al.*, 2007; Tatnall *et al.*, 2010).

As an interdisciplinary approach, ANT has great potential to contribute to providing better insights into the interplay between ICTs and society (Diaz Andrade and Urquhart, 2010), including how technology might facilitate or even impede activities and tasks carried out within a given social setting.

2.1 Key Concepts Of Actor-Network Theory (ANT)

ANT is based on a variety of concepts and an increasing number of IS researchers make use of this theory in their study. Relevant to this study are six key ANT concepts which are briefly described below. The case analysis and discussion section will illustrate its relevance to this study.

- Actor/Actant: Basically, these interchangeable terms refer either to human or non-human entities that acts or to which the ability to act is granted and as such can participate in a network. (An entity is a way of referring various things that can either be human or non-human). Common examples of actors include persons, animals, ideas, technical artefacts, etc.
- Actor-network: is a heterogeneous network of aligned interest formed by an assemblage of actors or elements that may include people, standards and object. This alignment is achieved by the translation of interest as well as via the enrolment of human and non-human allies into the network.
- Translation: Put simply, involves demonstrating how an actor's unaligned interest may become aligned in a network. Callon (1986b) identifies four phases or moments of the translation process and they are problematization, intersement, enrolment and mobilisation. It is not often the case that every translation must involve the four moments, and in practice, and as highlighted by Woods, the moments are not necessarily sequential and can sometime overlap (Woods, 1997).
- Problematization: The first moment of translation during which the initiator/focal actor seeks to define a problem that interest other relevant actors in the network and of which is consistent with his/her own interest (Callon, 1986).
- Enrolment: The moment of translation, whereby other actors in the network through means such as negotiations or persuasion or simply bargaining get aligned to interests defined for them by the project initiator or the focal actor (Callon, 1986).
- Irreversibility: refers to the degree to which it is subsequently impossible to revert back to a point where alternative possibilities exist (Callon, 1991).

It is important to note that the main focus of ANT when applied in particular social context is to enable human and non-human actors tell their story i.e. expressing their experience and challenges in the network “while coming into existence”. From these insights, it becomes possible to examine the motivations and actions of all the actors in this heterogeneous network (Walsham and Sahay, 1999) making it possible to gain

new understanding into why actors act the way they do and why networks become established or conversely, why they fail to become established over time.

3 Methodology

3.1 Research Approach

The empirical case study took place in Nigeria over a period of 5 weeks. The empirical investigation was conducted within various primary health facilities across the country and the national directorate of its health sector. The rationale for choosing a case study is because this approach enables researchers carry out detailed investigations with a view to provide an analysis of the context and processes involved in the phenomenon under study (Meyer, 2001). The contextual nature of case studies is further demonstrated in Yin's (1993) definition of a case study, which he describes as an empirical inquiry that investigates contemporary phenomenon within its real life context.

Within a case study, this research adopts a broadly interpretive approach where the subjective meaning that people create within their environment is studied and analysed (Orlikowski and Baroudi, 1991) with the aim of understanding the social context of an information systems in use (Oates, 2006). Data were collected via a qualitative approach. This approach elicits an abundance of rich data via various means which gives us opportunity to make knowledge claims based on the meanings deduced from the experiences of the people interviewed within a given social setting. In addition, it also allowed meaning to be drawn from the historical perspective of the documents analysed.

This study took an exploratory form (Yin, 1993) as it aimed to help with understanding the processes and behaviours that shape the innovative use of mobile phones to support HIS at the community level within Nigeria, in order to draw significant lessons for both research and practice.

3.2 Research Methods

The main data for this study was collected through a series of semi-structured interviews carried out over the five weeks period. The first set of interviews was carried out at the national office at the macro-level. The national office otherwise known as the national primary healthcare development agency (NPHCDA) is the national body responsible for co-coordinating all primary health care (PHC) efforts in Nigeria. Within this agency, ICT/operation staffs were interviewed as well as management personnel and project co-coordinators. The second set of interviews was conducted at 20 selected primary health facilities across the country. These facilities were selected from four out of the six geo-political zones (please refer to section 4.1). The two political zones that were left out were the North–East and North-West for safety reasons i.e. the crisis and unrest presently faced in most of the Northern parts of Nigeria. In total, 38 interviews were held with key actors (See Table 1) involved with this information system. The interviews were interactive and semi-structure. It allowed the participants share their experience of the situation under investigation. Additionally, they were conducted with full consent from the participants.

Also in order to gather some background and historic information about the project from the time of its inception in 2009, policy documents and reports about the project located in the NPHCDA office were studied.

Participants interviewed	Reason for inclusion
Health workers at primary health facilities(30)	Getting users perspective/provide awareness about key issues based on their direct involvement in the IS.
ICT Personnel (3)	Provide awareness about key issues and provides a technical perspective.
Management personnel (3)	To elicit insights about the decisions made and the rationale behind them.
Project coordinators (Zonal) (2)	Explore their views of the project at the zonal level.

Table 1.Summary of study participants

4 Background To The Healthcare Context

Maternal mortality is one of the five major public health issues that have gained increasing attention worldwide. The world health organisation (WHO) defines

maternal mortality “as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes” According to a 2012 report of the (WHO), every day, approximately 800 women die of natural preventable causes related to pregnancy and child birth. Sadly, this report also notes that 99% of all maternal death occurs in LDC with very high rates in sub Saharan African region, particularly known to be higher among women living in rural areas and underserved communities. Table 2 below shows the prevalence of maternal mortality in various regions throughout the world. Given this alarming trend on maternal mortality not only in Sub Saharan African countries but in other countries worldwide, the United Nations (UN) has made improving maternal health an important agenda for member states.

Some of the obstacles identified to be affecting maternal health include limited resources, decline in the number of available midwives, illiteracy, poor compliance of target group, and the unavailability of good data. Mobile technology solutions, whether when used to manage logistics, educate and remind patients, improve accountability and monitoring programmes holds immense potential for addressing some of these obstacles, particularly in non-affluent regions.

Region	MMR	Range of MMR uncertainty (Lower Estimates)	Range of MMR uncertainty (Lower Estimates)	Number of maternal Deaths
Developed regions	16	14	18	2220
Developing regions	240	190	330	284 000
North Africa	78	52	52	2800
Sub-Sahara Africa	500	400	400	162 000
Eastern Asia	37	24	24	6400
Southern Asia	220	150	150	83000
South-eastern Asia	150	100	100	17000
Western Asia	71	48	48	3500
Central Asia	46	37	37	750
Latin America	72	61	61	7400
Caribbean	190	140	140	1400

Table 2. Estimates of Maternal mortality ratio (MMR, Maternal deaths per 100, 000 live births) and number of maternal deaths. Source United Nations MDGs Region, 2010 (<http://www.unfpa.org>)

4.1 Case Study

This section provides a brief overview of the case setting and background information before moving on to the analysis of our case study.

The empirical setting for this research is Nigeria, a country located in SSA. With an approximate population of 150 million (National Population Commission, 2007), it has qualified as the most populous country on the African continent (World Bank, 2012). Presently, the country is made up of a federal capital territory (FCT) and 36 states which are grouped into 6 geopolitical zones namely: North-Central, North-East, North-West, and South-South, South-East and South-West. Also there are 776 recognised Local Government Areas located in the country with some of them having a population approximately less than 80,000 (DfID HSRC, 2000).

The delivery of Health care in Nigeria is at three levels namely: the primary, secondary and tertiary. These are managed by the Local, State and Federal government respectively. Recent statistics by the National Population Commission and the National Bureau of Statistics paint a dire picture of the current situation of health care in Nigeria. Worrying statistics include the life expectancy of both male and female to be between the range of 44-56 years, under fives mortality ratio to be 201/1000 live births, maternal mortality ratio to be 800/100 000 live births, and the prevalence rate of HIV/AIDS being 3.9% (NPC, 2007; NBS, 2007). From the statistics above, it is evident that the issue of maternal and child mortality remains one of the most serious developmental challenge facing the Nigerian health system.

Maternal mortality, the death of women during pregnancy, childbirth or in the first 42 days following delivery and child mortality, the death of an infant and children under the age of five (ICD-10), continues to be one of the major challenges facing Nigeria and most developing countries. Current estimates by development agencies such as the WHO and UNICEF reports that Nigeria has the second largest number of maternal deaths in the world (WHO, 2005a). According to a 2010 report by the NPHDCA in Nigeria, at present maternal mortality ratio (MMR) stands at 545/100, 000 live births

while infant mortality ratio and under 5's mortality ratio stands at 75/1000 births and 157/1000 births respectively. It is important at this point to mention that there are wide variations across the 6 geo-political zones in the country with higher mortality rates recorded in the northern zones. For example the north-east zone has the highest MMR with 1549 recorded cases of mortality per 100,000 live births. It has been argued that more than two thirds of maternal and child mortality that occur throughout the country particularly in these high-risk zones could be prevented.

Nigeria's progress towards reducing maternal and child mortality rates by 75% by the year 2015 (the 5th UN millennium development goal) has been very slow. In order to accelerate progress, in 2009 the National Primary Health Care Development Agency (NPHCDA) a body through which the federal government of Nigeria provides leadership in the development of primary healthcare, was tasked with setting up a scheme known as the Midwives Service Scheme (MSS) with the aim of improving maternal health.

4.2 The Role For Mobile Phones As An Informational And Service Delivery Tool To Facilitate Reporting Of Maternal Health Information.

Before providing a brief discussion on the role of mobile phones in this reporting system called MADEX, a brief overview of the health information system (HIS) in Nigeria is provided.

The HIS that captures health data in Nigeria (including maternal and child health data) is structured along the three levels of government namely the local, state and the federal government. Health information handling has been practiced in Nigeria by paper mainly and as such, paper-based records are still by far the most dominant record keeping system. (Very recently though it has been noted that computer has gradually been introduced at the state and federal levels). Basically, summary forms are used to collect data (including maternal health data) from health facilities in the communities, from the local government area office as well as the state and the federal capital territory. While this paper-based HIS is able to capture data on key maternal and child health indicators, much of the data cannot be used effectively owing to problems associated with analysing such huge data. Consequently in 2009, the NPHCDA recognized that the introduction of mobile phones in this HIS offered

the possibility of effectively collecting key health indicators from the primary level and reporting it directly to the national level in order to improve micro-level monitoring and evaluation. This was what led to the birth of the mobile phone information systems project MADEX. This system was implemented by Galaxy-Backbone ICT, a company owned by the federal government and charged with the responsibility of building and managing ICT infrastructure to all federal government agencies and Ministries in the country.

As part of this MADEX system, mobile phones were made available to about 652 primary health facilities across the country and designated health workers in these facilities were provided with a SIM card and a low-cost phone. A java application for routine data reporting was installed on each of these phones. This application allowed facility heads to capture key maternal/child data from their records and put it into this forms on the mobile phone. Subsequently, the data captured was forwarded in a text format directly to a server in the operations office at the NPHCDA on a monthly basis so as to update the national maternal morbidity, birth and immunization registry system (Figure 1).

Prior to using this application, facility heads being the key users were provided with training on usage and on mobile data reporting. Notably, the user interface of this application is menu driven. This menu consists of modules with each module catering to specific maternal and child health services provided by the primary health care facility. Figure 2 and 3 below shows screen shots of the application showing the main modules and the antenatal care and community outreach forms respectively.

The component of this initiative that concerns this research is the mobile reporting system (MADEX) within the primary health system in Nigeria used to strengthen a maternal and child health information system.

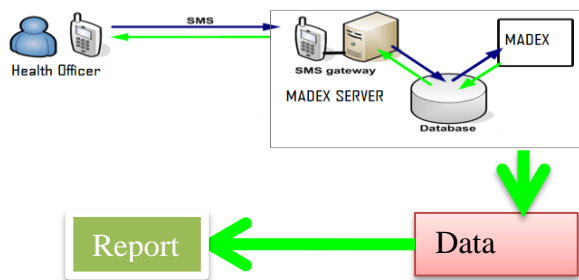


Figure 1. Overview of the mobile phone-based health information system (adapted from the NPHCDA report).

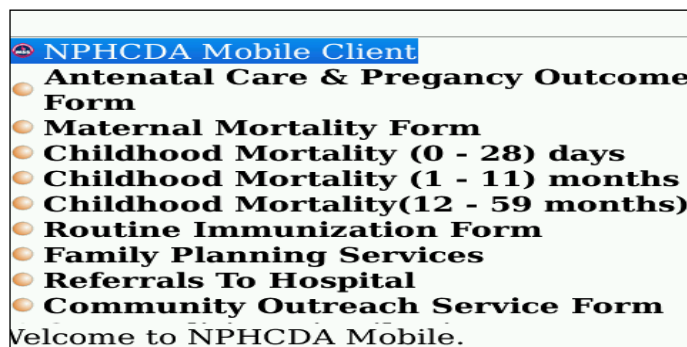


Figure 2 Screen shot of the user interface depicting the main modules

Community Outreach Service 123

No. of Outreaches conducted in the month

No. of Clients reached with Maternal Health Services

No of Clients reached with Child Health Services

Welcome to NPHCDA Mobile.

Figure 3 Screen shot of the user interface depicting the community outreach service form screen

Antenatal Care & Pregnancy Outcome	
Reporting Period (Months)	6
Total No. of Antenatal attendance	
No. of New Antenatal attendance	
No. of Pregnant Women with 4 & above Antenatal visits	
Total No. of Births	
No. of Live Births	
No. of Live Births with weight <2.5kg	
No. of Live Births with weight >2.5kg	
No. of Still Births	
Antenatal Care & Pregnancy Ou	

Figure 4Screen shot of the user interface that depicts the Antenatal form screen

4.3 The Use Of Actor-Network Theory (ANT) To Research The Use Of Mobile Phones In This Health Information System (HIS)

To appreciate the application of actor network theory ANT to this case study, it is first necessary to map the key concepts of ANT briefly described in section 2 of this paper to the key aspects of this mobile phone-based HIS. This mapping is provided and summarised in Table 3.

In applying ANT to this study, it was necessary to adopt the following steps:

First, it was necessary to identify stakeholders or key actors. Bearing in mind that an actor is someone or something that can make an impact or be affected by the impact of another as the regards the situation under investigation. In the context of this study, key actors identified include the primary healthcare workers, midwives, mobile phones, mobile communication service providers and communication network, I.T operations personnel's, programme designers and software applications. Following the identification of all the relevant actors, the next step was to investigate the actors through interviews by examining their motivations, actions, roles and their relationships with other actor in the network. The third step that followed was the identification of linkages between relevant actors in other to form the actor-network. Simply put, this network is an alliance of human actors as well as non-human actors. The key here is to carefully align the interests of the actors with that of the technology otherwise we may be faced with a situation where the different actors are "making off on their own" (Latour, 2005). It is necessary to point out at this point that in the context of ANT some of the "things" that allow alignment to be achieved include

work–routines, incentive structures, training, contracts, etc (Monteiro, 2000). Monteiro further explains that in an actor- network, alignment is not achieved as a result of some top-down plan rather it is achieved through a process of bottom-up mobilisation of heterogeneous entities.

With the third step completed, it is then time to apply the techniques of ANT which includes identifying irreversibility. This requires understanding to what degree say the technology introduced or new work patterns introduced are going to become difficult to change. The insights gained from this process will enable us to identify potential factors that may stall or stimulate the acceptance of the technology.

Some of these factors may include attitudes of actors, emotions such as trust or the lack thereof, external factors such as funding, network from telecommunications provider etc. Reflections from this process may give rise to possible actions that could help promote stability of the network hence resulting in successfully embedding the technology within the given social setting.

ANT Concepts	Relevance to case study
Actors/Actant: actors or actants are the participants in the given network. These actors can be humans and non-humans. (Focal actor-key person driving the initiative).	In this mobile reporting system, the actors in this network includes mobile phones, facility heads and health workers at the primary health centres, Programme initiators, planners, donors, state and local government officials etc.
Actor-network: a heterogeneous network of human and non-human actors of aligned interest, working to achieve a common goal.	In this system, the heterogeneous network is composed of human and non-human elements that linked together over time (Callon, 1991). These elements include mobile phone technology in conjunction with the user application, people, narratives, text etc.
Irreversibility: refers to the degree to which it is subsequently impossible to go back to a point where alternative possibilities exist (Walsham and Sahay, 1999).	The issue of irreversibility in this context will require an understanding into what degree the technology or new work pattern can remain fixed and become difficult to change. So for example some of the factors that may influence irreversibility include attitudes of stakeholders, external influences such as government policy etc (McBride, 2003).

Table 3. Key concepts of ANT and relevance to the mobile phone-based information system.

5 RESULTS

Moving now to the results of the research, the development of themes and key findings was achieved by careful reading and reflecting on the interview notes. In this section, the key findings identified are outlined in Table 4 with relevant quotes followed by a discussion.

Theme	Quotes
Efficiency gains: making the process of reporting of health data and the management of MNCH (maternal and neonatal child health) data easier.	“It is great; mobile phones help us save plenty of time.... Consider the poor condition of most of our roads and think about how long it would take us to travel to gather maternal/child health data from the primary health facilities around the country and then send it to Abuja (the national where the NPHCDA office is located) for it to be acted upon.”
Concerns about continuity beyond donor-funded period: As the initiative is not yet fully institutionalised and aligned with the goals of the national health system.	“From its inception, the overall project has been funded from debt relief grant; The greatest threat to its continuity will be the uncertainty about continued funding beyond the commitment of the grant”.
Minimal involvement of primary health facility heads in the planning and decision making process - as regards the use of this mobile phone application.	“We were trained on how to use the MADEX phone to report information. We send this information, but we don’t know much about how it is used or who gets to see it. It would be nice if they (those at the national office) communicate with us about these things.

Theme	Quotes
Diminishing/low level of interest - among primary care workers in using mobile technology owing to the lack of reward or incentives for taking up a new roles and also because of a very top down implementation approach which saw health workers having little or no input in the negotiation and the decision making process.	<p>“....We have now been given additional work of collecting and reporting this information.... Nobody said take something oh (meaning incentive) for this additional work we want you to do. It would have been nice to receive something”.</p> <p>“I know my report for the month is overdue. But I do not have the phone here with me at the facility, it is at home..... But I will bring it so we can report the information.”</p>
Absence of vision - to exploit capabilities of mobile phones for decentralized use at the local level to support the fight against maternal and child mortality.	<p>“The mothers will be happy for us (primary health officers) to send them information or reminder using mobile technology. Sometimes we use our own phone to communicate with them”</p>
Infrastructure issue	<p>“..... On certain occasions when we receive data from the primary health facilities there are instances where the data is lost in during transmission.....Whenever this happens, we get in touch with the facility head and request that the information for that month be resent.”</p>

Table 4. Set of themes and quotes that emerged following the first round of data collection.

6 DISCUSSION

The network of aligned interest that enabled the kick-off of the mobile application data exchange system (MADEX) project can be considered to have contained four broad groups of human actors, in addition to the MADEX technology which consists of the mobile phones, user application, the data as well as the server in the operations centre of the NPHCDA itself as a non-human network. These four groups of human actors consisted of 1) the project initiators and key management personnel at the NPHCDA, 2) the I.T personnel responsible for managing the operations centre, 3) the state and local government officials and 4) the health workers at the primary health facilities who interact directly with the mobile phone application.

An examination of this network through the lens of ANT sheds light on the fragile state of the network. By describing the network as fragile, we simply mean that up to the point of collecting data for this study, the network has not yet attained that state of irreversibility (Callon, 1991). The following discusses some of the reasons why this is so.

The enrolment process. In an effort to establish a solid and durable network, the proper enrolment of actors is fundamental. Simply put, enrolment means that the proposed technology and initiative as a whole becomes accepted by those being enrolled. No effort was actually needed to be devoted to the enrolment of the first group of actors (as mentioned above) since as managers of the project, their interests were already aligned with the initiative from the onset. Also, interviews made it clear that the second group of actors were directly recruited as I.T personnel for the purpose of this project during its inception and as such again no effort was devoted to their enrolment in the network. The situation is however different in the case of the third and fourth group of actors.

The third group of actors i.e. the facility heads at the primary health facilities are the key users of the mobile phone application. The role of these persons is pivotal to this initiative as they are responsible for collecting and collating data on key indicators of the midwives service scheme and transmitting it in text format to the server in the operations/I.T unit in the NPHCDA office. Interviews with this group of actors made it clear that while they were provided with training on how to interact with the user interface of the MADEX phone, they had not been carried along in terms of sharing the vision of the importance of this aspect of this initiative nor have they taken part in its planning. As a result, they expressed poor understanding of the vision and benefits of introducing this technology. Further, they also demonstrated a poor awareness towards the impact of this technology in the wider scheme of improving maternal and child mortality. This group of actors also pointed out that they missed evidence of a transparent link between the routine information they reported on the MADEX phone and what is actually taking place at the facility level as regards maternal and child health. At this point following a thorough analysis of the situation, one can argue that problemization has not taken place. Simply put, although this group of actors have been given a role to play in this network i.e. the collating and reporting of key MNCH

data, the project initiators/focal actors are yet to define a problem that is of interest to this group of actors. With this understanding it is possible to say although this group of actors are presently participating in the network; the innovative use of mobile phones has not generated interest among this group. In other words, their interest is not yet aligned to that of the technology. This obviously accounts for their diminishing level of enthusiasm in using the mobile phones to support the delivery of care in this new and improved way. Therefore to realise the full potential of the use of mobile technology solutions and at the same time to make its use appear more meaningful to this group of actors, it is important that at the onset, the project initiator or focal persons managing the ICT strategy defines identities and interest of this group of actors that is aligned to its own. A typical example would be for the initiator to relentlessly communicate the idea the role of mobile solutions to support the vision of transforming health service delivery. In communicating this vision, the initiator/focal actor can imply some of the following: “you will enjoy an enhanced reputation professionally and gain recognition both locally and beyond by being part of this novel health sector reform”. Additionally, creating a visible and direct linkage between the maternal health data being reported to the NPHCDA and events taking place at the primary health facility is a good strategy as well. Another useful strategy will be to create opportunities for local use and demonstrate local relevance. So in addition to reporting information on key MNCH data, mobile phone can also be put to use at the same time in such a way that it can provide direct relevance to improving maternal and child health at the local level. This way, the level of interest and acceptance of this technology within the health system will increase making it difficult to revert to a point of not using it. At this point, where the interest of this group of actors is aligned with that of the focal actor, irreversibility is more likely to occur giving rise to a stable network in this case a situation where this new way of working (i.e. with mobile phones) can continue to exist over time.

Some suggestions as to how mobile phones can become locally relevant will be to use this technology to enhance communication and information exchange between healthcare practitioners at the local level as well as to empower citizens. Mobile phone can be used by health workers at the facility to send alerts and reminders directly to the target population group i.e. new mothers and pregnant women about issues such as vaccinations for their children. This reminders and alerts serve as an

important medium to encourage adherence and empower pregnant women and new mothers to make right and timely decisions concerning their health and that of their infant.

Again as regards local relevance, mobile phone can play a dual role of assisting community health workers (CHW) to organise their schedules for outreach and at the same time effectively support the coordination of activities between themselves and facility heads at the health centre. This also means that in cases of emergency, primary health facility workers and CHW can work together to enhance their ability to respond to maternal and child health issues at the local level promptly. The above actions will not only impact on improving maternal health at the local level, it will also help to achieve alignment of interest of these actors in the network.

Finally, moving on to the fourth group of human actors i.e. the officials of the various local governments and states, it is worth mentioning that as a strategy for aligning the interests of this group of actors to the overall initiative, they were made to partake in the signing of a memorandum of understanding. This memorandum requires that the states and local governments be fully committed and involved with the support and management of the initiative as a whole in their respective states and local government areas. However, interviews made it clear that although some state and local governments are making efforts to honour this agreement, many are yet to give the initiative their full support. Again, a situation that highlights a high level of involvement and ownership and benefits at sub national levels can be a useful strategy in aligning the interest of this group of actors to the initiative as a whole.

Having examined the actions and motivations of human actors from interviews, the next step will be to examine the fifth group of actors i.e. the MADEX technology; a non-human actor consisting of the hardware i.e. the mobile phone, the software application and the MNCH data. Obviously, since the technology as a non-human actor cannot grant interviews or tell a story as it were, a suitable way to allow the technology component as an actor to relate its own experience will be to listen to other actors talk about their association or interaction with the technology and by observation during field visits.

The following paragraph provides a brief account based on observations during field visits and the story of other actors. Here, the hardware i.e. the mobile phone is given an imaginary voice to speak for itself in the first person.

Mobile phone “I am used as a tool in this system to report data on key maternal and child health indicators in a fast and effective way from primary health facilities across the country to the national office to enable decision makers to channel their effort and resources correctly so as to improve maternal and child health. I am considered to be essential with much potential but apart from being used once or twice a month to report data, I am stowed away most of the time in a locker and not put to use. I could serve two purposes in order to increase my relevance. I could be used both to report the routine data and also to enhance the communication of knowledge and information at the local level to support the overall goal of improving maternal and child health. But that will require the initiators and managers of the project to include this additional role in their overall plan. The workers at the facility and the target population welcome my use to deliver a better preventive and predictive care in a new and improved way at the facility level. The more I am put to use at this level, the more my relevance will become recognised and I could possibly become a permanent part of the information infrastructure used to support healthcare delivery in Nigeria across all levels of care”.

The narrative above reflects how the mobile phone is only put to use between one to two days a month to report routine data to the national office after which it is stowed away and sometimes it is not even in the vicinity of the health facility. This highlights an important finding that while so much emphasis is being placed on reporting routine data upwards to populate the national maternal and child health data base to improve monitoring, attention has been diverted away from the fact that decentralized use of the information as well as the technology at the local level can also contribute to the accelerating the pace of achieving the overall goal of this initiative which is reducing maternal and child mortality by 60% by the year 2015. Since this is the case, this technology faces a major struggle of “coming into being” in this network as it is yet to become indispensable or used as an everyday tool by primary care workers at the local level to support their delivery of maternal care in new and improved ways. Therefore in order for this network to become established over time, a key step will be

to put this technology to use in such a way that it becomes more useful at the local level by directly impacting positively on maternal and child health.

Also, as regards achieving an irreversible network, we contend that there is need for the enrolment process to be carefully thought out such that it properly addresses issues such as attitudes, motivations etc, of key actors. The aim here should be to allow the actor groups, for instance the government officials, to recognise their role in the network themselves as opposed to this role being expected from them or even imposed. Clearly, the best way to achieve this is to devise strategies that will promote their interests (whether social or political) and align (or translate) it with the overall initiative as well as the technology in order to reach a point where new work patterns, attitudes and the technology itself becomes socially embedded and embraced by the all the actors within the network.

Additionally, we identified two key factors namely funding and absence of strong ICT strategy that could play a role in preventing the continuity and stability of the network. As regards funding, findings from interviews as well as project documents made it clear that presently this project as with similar health projects in less developed regions relies mainly on support from international agencies and grant awarding bodies. While this is good in the short term, there is little or no chance of the initiative surviving beyond the donor period. Therefore it is important that initiatives such as this become aligned with the long term goals of the national health system so that it can get budget attention under the federal, state and local government.

Revisiting the key questions this paper set out to investigate; it can be argued that aside from some pockets of minor issues, mobile phone technology has been used successfully to improve routine maternal and child health information operations throughout Nigeria for the purpose of monitoring key maternal and child health indicators throughout the country. But the issue of sustainability and wide spread acceptance has to date not yet been achieved. For example as mentioned previously, we are yet to see decentralised use both of the information and technology at sub-national levels. As pointed out earlier, examples of local use could be to support compliance of patients both behaviourally and medically and to support information sharing between health practitioners at the lower level of care. To answer the question

why is this so, a broad explanation is given which is that the process of establishing a network with stable group of actors and aligned interests related to the goal is yet to be achieved. Undoubtedly, while this is not a simple process to achieve, we argue that relentless communications and negotiations between the initiator(s) and key actors is important to eventually bind the interest of all actors.

Finally to answer the question of the impact so far of the ICT strategy (i.e. the MADEX system) in improving maternal health, we believe presently that mobile technology is impacting positively in improving maternal health as it has brought improvement to the process of data management and decision making. However at this point it is difficult to say whether such improvement at the moment correlates to real improvement at the local level. However, it is clear that a greater utilization of mobile solutions at the lower levels of the health system as well, can have a stronger impact on maternal health and possibly accelerate progress towards meeting the MDG 4 and 5.

7 Conclusions

This case study provides some practical implications for both theory and practice. On a practical level, it has provided empirical evidence demonstrating the contribution of mobile phones in providing operational efficiency to the process of monitoring maternal health indicators throughout Nigeria.

Particularly, it highlight how mobile solutions brings efficiency into the process of reporting, monitoring and managing health data for the purpose of generating timely and reliable information that decision makers can use. Additionally it clearly demonstrates its potential for offering both preventive and personalising healthcare to citizens both at state and community level in order to empower and uphold their human rights. Consequently, stakeholders of health system in LDC need to be more aware of best ways to exploit the capabilities of this simple and cost effective tool, in order that it might provide clear benefits by addressing some of the key challenges facing health systems.

Also, this case study is yet another indication of how seemingly unimportant human, organisational and political factors can influence the successful take-up and sustainability of technology within a social setting. It therefore asserts that despite the technical excellence of mobile phones as an efficient tool for information and service delivery within the health system, project initiator(s) need to carefully and properly think about the implementation process particularly as it concern the problematizing of the initiative for different actors/actor groups.

Theoretically, this paper contributes to the usefulness of ANT concepts for analysing the introduction and use of mobile-phone technology to improve routine maternal and child health information operations throughout Nigeria. It further adds to the body of knowledge about the potential of using mobile phone-based information system as a tool to deliver 21st century healthcare to citizens.

The use of ANT as a theoretical lens offers explanations on how mobile phone as a technology may become acceptable and taken up by certain groups of actors. It revealed potential factors that could inhibit a network, hence preventing it from being established or reaching a point of irreversibility. Finally, ANT helped to identify possible actions that may contribute in making this network durable. A typical example is the problematizing of the project in such a way that the interest of key actors in the network gets “locked-in” so as to prevent the network from disintegrating with key actors “making off on their own” (Latour, 2005).

A limitation of this study is that having conducted just one round of interviews, enough data may not have been captured to cover some of the issues in-depth. However, since this research is still in progress, we hope to cover more details in-depth in the future.

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